Faculty Use of Tablet Computers at the University of Ontario Institute of Technology

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Abstract

Abstract: This article describes instructor use of tablet computers for personal use, research activities and teaching practices within the Faculties of Science and Engineering at UOIT. The benefits of tablet use were evaluated on the basis of types of usage, personal and professional productivity and the "richness" of the overall computing experience. Major findings include the enhanced ubiquity of computer use by faculty as a result of increased mobility, and the modification of pedagogical practices before, during and after lectures. The article also reports on faculty speculation regarding the effects of tablet use by students as well as suggestions for improving tablet computer design. The article concludes with a number of recommendations for the expanded use of tablet computers within higher education settings.

Résumé : Le présent article décrit l'utilisation par l'instructeur d'ordinateurs tablettes à des fins personnelles, pour des activités de recherche et la pratique de l'enseignement au sein des facultés de sciences et génie de l'UOIT. On a évalué les avantages de l'utilisation de la tablette en fonction des types d'utilisation, de la productivité personnelle et professionnelle et de la « richesse » de l'ensemble de l'expérience de traitement. Parmi les conclusions importantes, on trouve l'ubiquité améliorée de l'utilisation de l'ordinateur par la faculté en raison de la mobilité accrue et de la modification des pratiques pédagogiques avant, pendant et après les cours. Le présent article traite aussi des suppositions du corps professoral quant aux effets de l'utilisation des ordinateurs tablettes par les étudiants et de

suggestions visant l'amélioration de la conception de ces ordinateurs. L'article termine sur des recommandations pour une utilisation accrue des ordinateurs tablettes en enseignement supérieur.

Introduction

"The tablet has become an integral part of my lecturing style."

(UOIT Faculty Member, Winter '05)

Opened in 2003, the University of Ontario Institute of Technology (UOIT) is Ontario's newest university. UOIT was created to fill a void in post-secondary education in science, mathematics, technical education and in emerging engineering disciplines. UOIT is committed to the use of information and communication technology (ICT) to enhance learning outcomes. To achieve this end, UOIT was established as a "laptop university" where all faculty and students would be provided with laptop computers. To support the use of laptop computers the university undertook significant investments in IT infrastructure, faculty development programs and purposeful hiring of faculty with technological expertise for teaching and learning with technology. The use of teaching and learning technologies is a requirement of the faculty contract.

The university's two largest Faculties (Engineering and Science) faced unique challenges with regard to employing laptop computers for instruction. The common need for numerical or graphic representations required a laptop solution that differed from what served the rest of the university. To address the presentation and notation requirements of scientific languages in 2004 the engineering and science faculties decided to investigate the benefits of tablet computing and to document faculty's daily use of table computers within an academic and scientific environment.

UOIT Webcentric Learning Environment

The webcentric learning environment at UOIT provides all faculty members with laptop or tablet computers and requires students to lease a standard-issued laptop computer (IBM ThinkPad) from the university during their four years of study. Rather than adopting a "purchase model" for the laptop program, the University decided upon a "lease model" to ensure a support and service level similar to that found in the private sector. In choosing a lease arrangement the university greatly simplified a) software procurement, (negotiating educational pricing of course specific software), b) annual re-imaging of laptop computers, c) insurance for damage or theft, and d) bi-annual replacement of laptop computers. Leasing has enabled the university to enhance support through efficiencies due to standardization and centralization.

A unique feature of the UOIT laptop learning program has been the inclusion of course specific software required by students and faculty on each laptop computer. Centralized software procurement has resulted in significant cost savings to students and faculty resulting in approximately 300 software packages available to students and faculty

members on a faculty-specific or course-specific basis.

UOIT ICT Infrastructure

A critical component of the laptop learning program has been the planning and construction of integrated wired and wireless network environment best described as an "anywhere-anytime" ubiquitous computing environment. All lecture halls and tutorial rooms as well as informal learning spaces (hallways, restaurants, foyers, study rooms and the library) are equipped with both wired and wireless Internet access to the university network. Students can access university network services and the Internet through either ethernet connections provided at each seat, or through wireless access points within all lecture halls or seminar/tutorial rooms. Students with access to the university network can print to shared networked printers located in classrooms or within specific printer locations across campus. Ubiquitous network access has allowed students and faculty to work with electronic learning resources and online library materials from any location on campus or from any location where they have access to the Internet.

Large lecture halls were designed to facilitate the use of laptop or tablet computers. All lecture rooms were equipped with "smart" podiums equipped with docking stations for faculty laptops, connections to multiple data projectors, the university network, the Internet, the university's learning management system (LMS), and an amplified public address system. The podium also has controls for the room lights. Smaller seminar or tutorial rooms have been equipped with multimedia instructional technologies although configurations in smaller rooms followed different infrastructure designs including greater use of wireless connectivity. In summary, the technological features of UOIT provided the opportunity to research the advantages and/or challenges that tablet computers presented to university faculty without the influence of uneven local technical infrastructures.

Tablet Computers

Tablet computers are generally small (screen size 12.1 inches or less), light weight (2.0 kg or less) and allow input from keyboard, mouse, or interactive pen (Lindsey, 2003; Mendelsohn, 2003). Some tablet computers are designed similar to traditional laptop computers but with pen-sensitive screens that can be swivelled to a horizontal position for pen-based input. Tablet computers that come equipped with an integrated keyboard are known as "convertibles." Other tablet computers function more like "electronic slates", with keyboards as optional devices. Both types use a Microsoft tablet operating system that enables pen-based writing to be "digitized" while also providing support for on screen sketching. The inclusion of technical enhancements to improve their operation, as well as the omission of optical drives helps tablet computers to generally outperform traditional laptops in battery life. Tablet computers have been accepted in many educational contexts where the flexibility of input is a definite advantage (McCloskey, 2004). McCloskey also notes that pen-based computing allows "users the power to incorporate free handwriting into the personal computing experience." Toshiba Canada (2005) reports that "Tablet PCs have done well in a number of vertical market segments, primarily in training and education, sales, healthcare and financial service settings (p. 1)."

Purpose of the Study

The purpose of this research project was to determine the potential additional value of tablet computers within a "technology enhanced laptop learning environment" by faculty from the Faculties of Science and Engineering. For the purpose of this study "additional value" was defined to be any added benefit provided by tablet computers over conventional laptop computers while more specifically "value" was determined by the "richness" of faculty's overall computing experience in instructional, research and personal settings. This research project is part of a larger ongoing research program at UOIT designed to investigate the benefits of information and communications technology (ICT) to student learning along with research into pen-based computing.

Literature Review

Laptop computers have the capacity to put "ubiquitous computing" into the hands of users (Miller, 2004), as well as supporting "mobility" allowing users to work anywhere at anytime. Recent developments in both hardware and software have contributed to reductions in weight while more powerful laptop computers have increased the utility of laptop computers among all users. Miller (2004), Shirley, Pierson, Trytten, Rhoads and Court (2002), University of Minnesota (2005) and Windschitl and Sahl (2002) have suggested that laptop use within higher education has had a positive effect on student learning enabling students and faculty greater opportunities for collaboration and knowledge construction, exchanging files for group projects and exchanging ideas through synchronous and asynchronous discussion forums. The availability of laptop computers to faculty makes it easier for faculty to design learning activities where the exchange of ideas is often spontaneous, originating from a variety of locations (Windschitl & Sahl, 2002).

At the time of this writing, few publications were found that reported on the use of tablet computers in higher education. Of those reported a small minority focus on faculty use of the tablet computers within the teaching environment. Lindsey (2003) describes his use of a tablet computer to create 'lecture shells' in PowerPoint for use in an e-learning environment. Lindsey states that the tablet computer decreased his preparation time as the outlines used can be augmented with graphics and annotations while in front of the class. In a paper describing insights gained by the authors through their use of tablet computers over the course of a year, literacy professors Thomas, King and Cetinguc (2004) compare tablet computers favourably to the older technology of books. They explain that

The tablet [computer], with its robust combination of the best in computer technology and age-old and age-old literacy tools (namely pen, paper, and portability), is a type of device that sagacious literacy educators should consider for blending traditional literacy with advancing technology. (p. 3964)

The universities of San Diego, Virginia and Washington have been investigating the use of tablet computers as part of a 'Classroom Presenter' system (Anderson, 2004; Anderson, VanDeGrift, Wolfman, Yasuhara & Anderson, 2004; Simon, Anderson, Hoyer & Su, 2004).

The presenter, which consists of an electronic slide application displayed from a tablet computer or through a networked computer, allows the instructor to annotate slides and consequently allows the presentation content to be modified for each audience. In a series of papers which evaluated the use of tablet computers by faculty at Seton Hall University, Cicchino and Mirliss (2004) and Weitz, Wachsmuth and Mirliss (2004, 2006) reported that faculty who used the computers in their classrooms felt the computers offered meaningful enhancements for teaching. These authors state that the computers are particularly well suited for fields, including the natural and social sciences, that require freestyle drawings of diagrams, symbols and other inscriptions.

Several investigators have reported high levels of tablet adoption by higher education faculty (Hayes, Powell, Pendergrass & Vekovius, 2004; ITRC, 2002; Lindsey, 2003; Mendelsohn, 2003; Microsoft Corporation, 2002, 2004a, 2004b; Simon et al., 2004; Weitz et al., 2004). Where use of tablet computers in educational settings has been discussed in the literature, it has been primarily descriptive. Some articles describe a variety of uses by higher education faculty members including note-taking (Anderson et al., 2005), writing comments on student assignments (Foster, 2005), sketching complex math formulae and in class group work (Thomas et al., 2004). Additionally, the literature describes faculty members creating handwritten instructional materials using tablet specific programs such as Journal© or One Note© spontaneously during lectures or tutorials where "just-in-time" presentations were used in response to inquiries from students. As with traditional laptops many of these applications also permit the inclusion of pictures, as well as audio and video clips into presentations as well as handwritten comments. These applications also allow faculty to create learning materials for use in lectures which can later uploaded into a university LMS. The advantage for students according to the authors was to help students to search text and highlight important aspects of the notes by the use of "flags", which are notations within the text indicating topics for further reference within both programs (Cicchino & Mirliss, 2004).

Not all literature on tablet computers describes faculty use of tablet computers in a positive light. Weitz et al. (2004) found that faculty did not use many of features incorporated into tablet computers. Yet, when faculty were asked about their general use of tablet computers they replied that they found tablet computers valuable for teaching. The authors explained this discrepancy as primarily a result of the short time faculty had to explore all new tablet functions and the lack of specific training on tablet computer capabilities. Consequently the importance for even experienced computer users to be introduced to the new capabilities inherent in how to work with tablet computers is essential.

Design of Study

In 2004, prior to the beginning of the academic year, all 42 faculty members in the Faculties of Science and Engineering and Applied Science were provided with a Toshiba tablet computer (Protégé 3500 or M200). All faculty members at UOIT are well-versed in computer use and are required, as part of contractual obligations, to integrate computer

usage into all academic course work. As a consequence of their familiarity with computers, no further training with the tablets was offered to the faculty members. This study was designed to describe and document the perceptions of the faculty members and therefore no attempts were made to include a control group. In addition to gathering data from an online survey, data was also collected from a) individual interviews with faculty members who volunteered following completion of the survey, b) faculty journals regarding use of both tablet computer hardware and software, and c) a review of teaching materials developed using tablet computers.

Data Collection and Analysis

In April of 2005, all science and engineering faculty were invited to respond to an online survey regarding their use of tablet computers for professional activities, teaching and learning opportunities, engaging in research and general computing tasks such as surfing the Internet, taking notes, answering or writing e-mail use, online banking, and using the tablet computer for entertainment purposes. The response rate to the survey was 50% (21 of 42 faculty members).

Multiple data sets from the online faculty survey, transcripts of interviews, faculty journals and teaching materials were analyzed using both quantitative and qualitative procedures. Data were analyzed using commonly accepted qualitative data analysis methodologies (Miles & Huberman, 1995; Richards, 2005). The use of qualitative data analysis software allowed for the identification and connecting of tentative themes from transcripts, faculty learning journals and detailed notes kept by the researchers during the interview process. Visual mind maps and charting were used to check for connections and relationships among the observations and experiences of study participants. Researchers maintained an audit trail to document the process that was followed to arrive at their findings. Results from the analysis of qualitative and quantitative data were subsequently synthesized and later triangulated to minimize bias. Consequently, findings derived from one data source were compared to those from other sources to ensure corroboration across the data sets. The reported conclusions were drawn only from findings that occurred in multiple data sets.

Survey Administration

An online survey using both closed and open-ended questions was developed to gather data about how academic staff perceived the usefulness of tablet computers within their teaching, professional and personal computing experiences. The instructors were contacted by letter to participate in the research and to complete the online survey. The small sample size and narrative nature of the data did not lend themselves to the use of tests of statistical significance. Survey results were analyzed for similarities and common themes. Responses were counted and simple percentages were calculated to provide a scale for agreement and/or common responses to questions on the survey. The use of numerical quantification was used to stress the relative importance of responses from participants.

Individual Faculty Interviews

Included in the online survey was a request for faculty to participate in a one hour follow-up interview regarding their tablet computer use. Twenty faculty members agreed to be interviewed and six were chosen to represent gender, discipline and teaching experience to participate in semi-formal interviews. During interviews, faculty were asked to expand upon their survey responses and to describe their tablet use over the preceding 12 months. They were asked which specific tablet functions they used and how their use differed from how they had used laptops previously, whether using a tablet computer for instruction had any observable effect on student learning and how tablet features (hardware and software) could be improved. They were also asked about tablet computer use for preparation of course materials, classroom use when presenting materials and presenting and explaining solutions to student questions. They were asked if tablet computers created new opportunities to change how they taught in and out of class (new pedagogical approaches) and if so, in what ways. Finally, faculty were asked for their thoughts regarding student use of tablet computers as these thoughts might become determinants of how faculty would use tablets in the future.

Findings: Four Themes

Upon analysis of the data, four themes emerged regarding how the introduction of tablet computers changed established computing behaviours by faculty: a) Enhancing mobility of faculty, b) Transforming the development of learning materials in and out of class, c) Enhancing faculty feedback to students and d) Altering instructional pacing during lectures. While each of the four themes is discussed separately, they constitute a constellation of change in the ways in which the introduction of new technologies may affect established practices.

In general, faculty members reported throughout the study that they did not feel that they had significantly altered their instructional practices, modified how they developed learning materials nor used their tablet computers any differently than previous laptop computers. Taken together the lack of self-reported change may be attributable in part due to how easily faculty adopted tablet computing functions into their personal and professional activities.

Enhancing ubiquity of computer use
Cicchino and Mirliss (2004) state that the "Tablet PC can be used almost anywhere and may make it possible for users to capture nascent design ideas as they spontaneously emerge" (p. 544). These notions of ubiquity and spontaneity were reinforced by our faculty survey responses and interviews. The authors suggest that one factor leading to notions of ubiquitous computing was the ease by which users (faculty) could use tablet computers in everyday settings (mobility and size) without changing their established patterns of behaviours. Sixty-seven percent of participants responded affirmatively when asked about whether the size of tablet computers contributed to greater mobility and their use in classes across campus. Faculty reported that in part due to the reduction of weight they were more inclined to take tablet computers to meetings or to move about campus with their tablet computers. Additionally, faculty reported that they began using the tablet to

take notes during meetings. One faculty member noted: "I use it just as regular paper when I want to 'doodle' and jot down fragments of ideas/equations while trying to solve a specific problem." The introduction of pen-based computing which mirrored established working methods (paper note taking) with the introduction of a computing device was important in encouraging faculty to adopt new computing practices. These practices coincide with the findings of other researchers. For instance, Thomas et al. (2004) speculate that the tablet computer may contribute to a redefinition of literacy since the tablet computer acts as "a powerful sort of literacy toolkit/portal" (p. 3967). Cicchino and Mirliss (2004) supported the notion of a new literacy when they suggested that tablet computers more so than with laptops, may finally allow the potential for ubiquitous computing to come to fruition.

Transforming instructional practices & pacing

Although the use of PowerPoint as a means of presenting instructional materials seems well entrenched in most North American universities (Lindsey, 2003; Thomas et al., 2004), the introduction of tablet computers in this study appeared to change the manner in which this presentation software was used. In part due to the ICT infrastructure and laptop learning program, all faculty members created digital learning materials to inform their lectures and tutorials. All faculty members developed lectures using PowerPoint software. In some courses, notably in the Faculty of Engineering, in addition to PowerPoint students and faculty members worked with Solid Works while in engineering courses. Yet in all cases faculty reported using PowerPoint presentations to introduce topics or to "organize" their lectures. However, the introduction of tablet computers altered how faculty developed learning materials. Over half of all faculty members (52%) reported using tablet computers to prepare handwritten instructional materials prior to class, particularly if the class content included mathematical or formulaic material (primarily chemistry or physics). Rather than rely upon mathematical emulators to prepare class presentations, engineering and science faculty members wrote notes directly into PowerPoint slides with which they would then lecture in class. In other cases faculty used the ease of the pen-based input to prepare slides leaving space for completion during class. Still other faculty spoke of preparing "animation" slides using a sequence of overlying graphics using text or more often hand drawn graphics. When asked to describe whether tablet computers had an effect on instructional activities, most faculty reported a variety of positive effects on classroom instruction including affecting instructional pacing, facilitating just-in-time nature of augmenting verbal explanations, employing step-by-step instruction. As well being able to write or fill in PowerPoint "shells" altered instructional pacing to a "handwritten" pace rather than a "click and gallop" tempo.

Often faculty spoke of "shells" which included both problems and/or partial solutions which would be completed during class thus more closely following the chalk and interaction /dialogue techniques found in more "traditional" settings. As one faculty member stated, "What I give them is a sort of shell which has a lot of the text of the PowerPoint [presentation], and depending on how much time I have before the lecture, I edit that shell." The ease, simplicity and speed of editing learning materials were important for

faculty when both developing and editing slides. Faculty reported revising lecture materials at the last minute or making more substantial changes using handwriting from one lecture section to another due in part to the simplicity of "re-writing" their slides. The effect of effortlessly sketching ideas, writing class notes and using handwritten formulaic/graphic representation had the greatest effect upon how faculty lectured and was the most significant finding emerging from this study.

The most significant change to teaching practice appeared to be the effect on the faculty pacing of lectures. Faculty reported that tablet computers created a more "traditional" tempo to their lecturing. Often in large classes, faculty resort to lecturing using PowerPoint slides which they would constantly speak to or in some cases read. As described earlier, instructors often developed PowerPoint slides with space for anecdotal handwritten comments. The requirement (planned instructional practice) to write notes tended to slow the pace and tempo of the lecture. Consequently, faculty often described the pace in terms of creating a more "human" or "non-mechanical" rhythm to their lecturing. By relying on "just in time" pen input rather than solely using prepared slides, instructors found they slowed their presentation and concentrated on leading or "walking" students through problems using a handwritten step-by-step process rather than relying upon a projected pace. Instead of displaying prepared solutions to problems, faculty members wrote solutions to problems and reported asking students for suggestions more often than when using traditional laptop computers and prepared slides with solutions.

One faculty member described this change in lecture tempo in the following manner,

> On the other hand to do proofs of the theorems [in Mathematics], to give examples of some of the definitions, to do problems, you don't want those prewritten because I think, first of all you don't explain [the example] as well if it is already typed and you go too fast as well. And it is really useful I think to go through it step by step, and for you to just go, and I think it is actually impossible if you have it just pure PowerPoint or what ever, to go through it as effectively, really because when you do it you go through it step by step and you think about what you are doing as you are writing it and you tell them, "now I have to do this now, I have to do that now, I'm doing this", it is much more, you provide much better information at that point.

Yet another participant stated that,

> When I am writing it out every time, I'm sure I'm going first of all at a good pace, and I am talking about every step along the way from memory just to sort of make sure that I let them know why I am doing what I am doing.

While most faculty (81%) reported using PowerPoint to display course notes and other materials during class, the introduction of tablet computers enabled faculty to augment or annotate lecture materials such as those in biology where either re-drawing diagrams thus simplifying complex illustrations or spontaneous drawing conceptual schemas during class enabled faculty to enhance visual explanations for students The ability to annotate and label complex visual representations and/or to generate mathematical and/or chemical formulae proved to be invaluable to the instructors. One instructor described how tablet computers had changed how he developed course notes but also how he lectured during class. He commented on the ease of "writing" on slides rather than laboriously typing information into slides. He said,

> My usage of PowerPoint has changed—allowing for more 'skeletal' frameworks on slides and more flexibility during lectures. Recently I have started using Word documents with 'blanks' that the class participates in filling in. I can record their responses [directly into the document].

Faculty members reported that the tablet computer had a variety of effects on classroom instruction including influencing instructional pacing resulting from the just-in-time nature of augmenting verbal explanations and its use in problem-solving using step-by-step presentation rather than using PowerPoint slides which more often than not faculty members included preset solutions to complex problems (due to the complexity of rendering solutions in real time on a traditional laptop).

Another faculty member described how the tablet computer changed his instructional practices when he stated, "I find the tablet is VERY effective for lectures in large classes. Additionally, after the lecture, the [annotated handwritten] notes can be posted on [the university LMS]. This frees the students from the burden of note taking during lecture." Other instructors reported using tablet computers to facilitate greater student-faculty exchanges in class. In some cases tablet computers made active student involvement possible in providing/projecting solutions to the entire class through the use of the professor's tablet computer to share handwritten solutions.

Mathematics, physics and chemistry instructors noted that tablet computers enabled them to solve equations and other types of problems in a "realistic manner" by showing students how to proceed through the solution in a 'sequential' manner during a lecture. As a consequence their teaching occurred at a slower pace. When describing their altered pace of instruction, faculty often linked the overall tempo of the lecture with sequential instruction. While the benefit of a slower pace was raised by faculty, the scope of the study did not allow for observation or interviews with students to corroborate faculty observations. However, further research is being undertaken at UOIT regarding student use of tablet computers which may yield further insight into the effect of pacing and pen-based instruction.

The finding that pacing was altered through the use of tablet computers as well as greater use of sequential instruction and enhanced student-faculty interaction is a key finding in this study. Every faculty member spoke about pacing and how they were surprised at how tablet computers could so significantly alter their delivery of course materials.

Enhancing faculty feedback to students

Reporting on the use of tablet PCs at a major U.S. university, Foster (2005) described the benefits of "handwritten comments [on graded assignments] helped students feel more connected to the process of reading and writing" (p. B18). The present study found support for this notion with most Faculty reporting that tablet computers assisted them in providing detailed "in context" student feedback "online." Faculty described how they used the pen input method to provide comments within student papers (using the mark-up/overwrite tablet function) minimizing the time and management of collecting, grading and returning physical papers to students. The ability to write electronic comments on student papers more closely resembled their previous practice of writing on student hardcopy papers.

Faculty especially in science and engineering found that it was critical to write formulaic comments or to annotate drawings in engineering and using handwriting rather than typing comments within student papers. The electronic submission of papers, their "digital" grading, and online return to students, was of significant value to busy faculty.

Faculty noted that the tablet computers offered a variety of feedback options that laptop computers did not. One faculty member described how tablets improved how she provided students feedback. She stated, "Yeah, where I found the tablet found its niche for me was in student submission and marking of submissions. That's where I really, really found the usefulness as a tablet." Another instructor reported that tablets helped him do more. He elaborated on this by stating, "I found the tablet speeds things up in doing assignment solutions and marking. I don't know [if] the tablet speeds up marking [of] lab reports but I certainly prefer it than carrying around like fifty pounds of paper." The ability to include handwritten annotations while assessing the assignments gave this instructor permission to accept electronic submission rather than having the students hand in hard copy.

One benefit identified by faculty was the option of keeping "versions" of student papers (original and those graded) allowing faculty to review comments or grades throughout a course. As one instructor stated, "I have got a copy of their original and a copy of my annotated piece [which helps me follow student progress]." A small number of faculty expressed the view that they might in certain circumstances refer to previous student assignments and to their annotations to respond to academic appeals or where students grades were falling in a course and when students asked for additional assistance.

Faculty Perceptions of Tablet Use by Students

In addition to their own use of tablet computers, faculty members were asked to speculate about how students might benefit from pen-based tablet computing. The unique laptop-based learning environment at UOIT provided researchers with greater confidence that faculty perceptions or beliefs would be based on first hand experience of teaching students who *all* used traditional laptop computers for learning. When asked to speculate on the potential effect of tablet computers on student learning, instructors hypothesized that students would commonly use the tablet computer functions in class to handwrite notes or draw solutions or draw graphics based on professor's lectures. As one instructor stated, "if [the students] had a tablet computer they could sketch like I did when I went to school." Another faculty member speculated that if students "had a tablet computer, more of them would take notes using the format [pen-based input] that I've generated in class."

While the benefits to students using tablets were primarily descriptive (hand writing notes, sketching, more easily recording mathematical formulas), several faculty members speculated about what effect different computer inputs might have on learning. This omission was more a result of the speculative nature of the inquiry and the lack of direct faculty experience. However, what is clear from the survey and interviews was faculty member's "perception of benefit" to learners who could utilize the freedom of tablet computing for learning.

Faculty Recommendations for Improving Tablet Computers

Faculty members were asked to suggest improvements to the tablet computer platform. The suggestions included:

1. Adding a built-in optical DVD/CD-RW drive
2. Having a larger screen
3. Using more powerful processors
4. Having larger pens
5. Increasing the durability of the pen and its clip
6. Options for better video cards with more VRAM
7. Increasing battery life
8. Redesigning the tablet computer for simultaneous use of keyboard and the writing surface

While many of these suggestions are similar to most users of laptop computers, it is important to note how users still viewed tablet computers in terms of design, use, weight and power resembling traditional laptops.

This research project examined faculty use of tablet computers within a postsecondary science and engineering environment. While faculty generally preferred the tablet computer for instructional purposes and found it equal to laptop computers for personal use, a number of recommendations did arise.

1. Most faculty suggested that even though tablet computers closely resembled laptop computers in design, in order to make the best use of new tablet functions, a comprehensive professional development (P.D.) program be developed. Instructors suggested that P.D. address both technological aspects of the tablet computer (hardware and software) but also the potential use of tablets for teaching and learning. Faculty identified a need for orientation to tablet computers to better understand the new features that tablet computers offer and opportunities to explore how tablet computers could enhance instruction.
2. Faculty members suggested that docking stations be installed within "smart podiums" to facilitate easier connections to data projectors and other podium tools in lecture halls thus creating a similar infrastructure to that provided for traditional laptop users since port replicators are available for traditional laptops.
3. Many faculty identified disappointment with tablet software availability and that existing software packages did not include tablet functions such as pen input directly into Word documents, rather than "over writing" text on documents.

Conclusions

Tablet computers have been a welcome addition to the teaching tool-box for science and engineering faculty at UOIT. To a large extent, instructor use of tablet computers made ubiquitous computing more of a reality. The unique handwriting and drawing capabilities of the tablet computer and its associated software allowed instructors to provide more extensive and augmented notes to students before, during and after each class. The use of tablet computers also influenced the way instructors behaved within their classes allowing for slower pacing and additional types of interactions between students and themselves. While the instructors hypothesized positive effects of student use of tablet computers, further investigation is necessary to determine actual effects. Further studies regarding innovative usage of tablet computers for instructional purposes also need to be pursued to follow faculty as they acquire new skills, and greater confidence in using pen-based

computing.

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